Space Weather Technical Forecast

Issued on Monday, 16 October 2023 at 01:16 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1, peaking to start UTC working week and perhaps again midweek. Rising Chance of R1.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity recorded at GOES 16 and 18 was Low in the past 24 hours, with occasional low-level C-class flares, peaking with a C3.9 at 15/1633UTC from AR3464 near centre-disc. Other small flares were generally concentrated near the oncoming eastern solar horizon.

There are now up to six sunspot regions on the disc, with no one group dominating in terms of activity, in part due to the relatively magnetically simple front sided cohort. The main observed trends in the period were slight trailing spot proliferation and spreading in AR3464 and AR3465, although both were simple Mt Wilson Beta dipoles and Zurich C-groups.

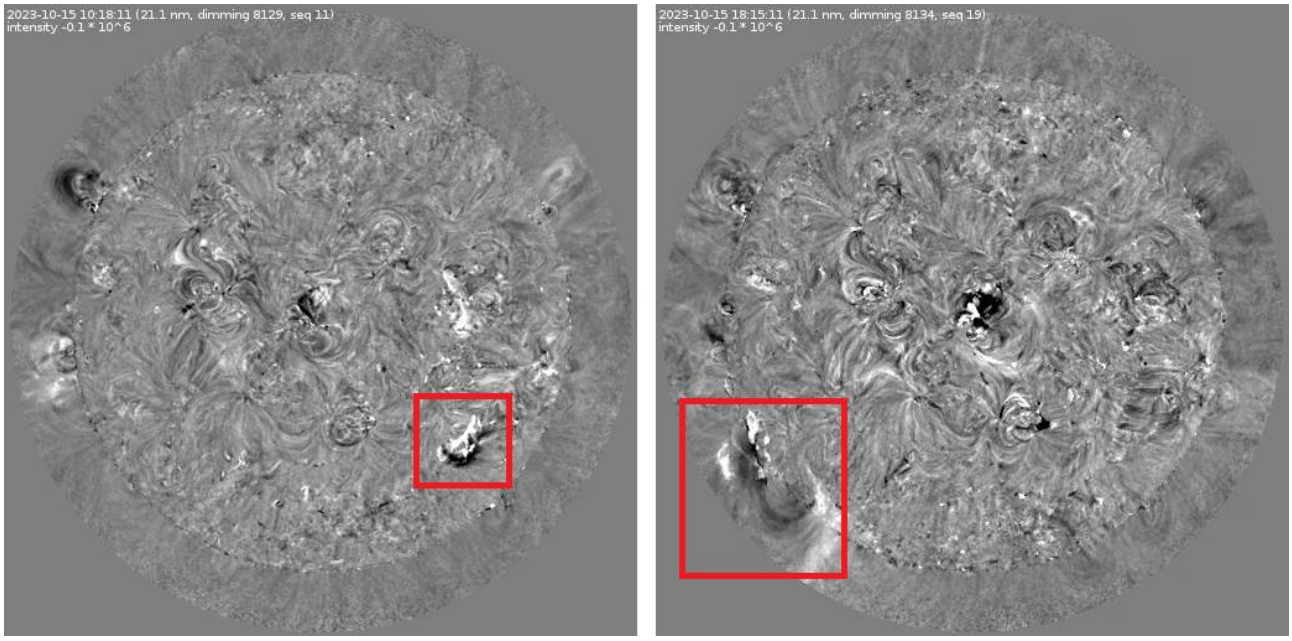

Figure 0: SIDC ROB-derived time integrated AIA211 imagery, showing two possible CME-producing events seen in the period. At the time of writing, neither is thought likely to have any component on the Sun-Earth line.

There were a few potential Coronal Mass Ejection (CME)-producing events seen in the 24 hours. Perhaps most notable amongst these was a filament eruption to the west of CH60/+ from the southwest quadrant. This was visible in H-alpha at 15/1004UTC with an associated filament channel in EUV. A faint and narrow CME was subsequently seen in Lasco C2 imagery, apparently heading largely west. This has been analysed and although modelling is awaited, provisionally it appears too narrow to have any Earth-directed component. In addition to this event, a prominence

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eruption was seen from the southeastern limb at 15/1809UTC. Coronagraph imagery is awaited for this event, however any Earth effects from this longitude are considered unlikely.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, suggested an exit from the tail of the fast wind from CH58/- into a slow regime, with the phi angle rather variable in the first 12 hours before settling on mainly negative (towards the Sun) to end the period.

The solar wind speed showed a continued decline from early Slightly Elevated highs around 475km/s, eventually reaching 375. The solar wind density was steady at Background levels in single figures ppcc throughout, while the IMF was similarly unremarkable at Background levels below 3nT, with the north-south component ranging between +3 and -2nT.

The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels, peaking in the UTC evening of 15 October around 100pfu. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 16/0001UTC was 1.58e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a slightly rising Chance of M-class flares at first in the four-day period as a result of potential returning regions.

Solar Wind / Geomagnetic Activity: CH60/+ should arrive later in the UTC day of Monday 16 October, bringing a Chance of G1. Up to two CMEs then feature in the forecast, both low confidence and both glances, but potentially crossing 1AU later in the UTC morning of Wednesday 18 October, and giving a further Chance of G1, probably with a preceding lull in activity as the CH60 fast wind matures.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux will most likely remain at Background levels.

High energy electron flux (greater than 2MeV) should now show a slight rise within the first UTC day, but will probably be attenuated at GEO by the arriving fast wind. A more uncertain recovery is then expected through midweek, complicated by the possible passage of up to two transients.

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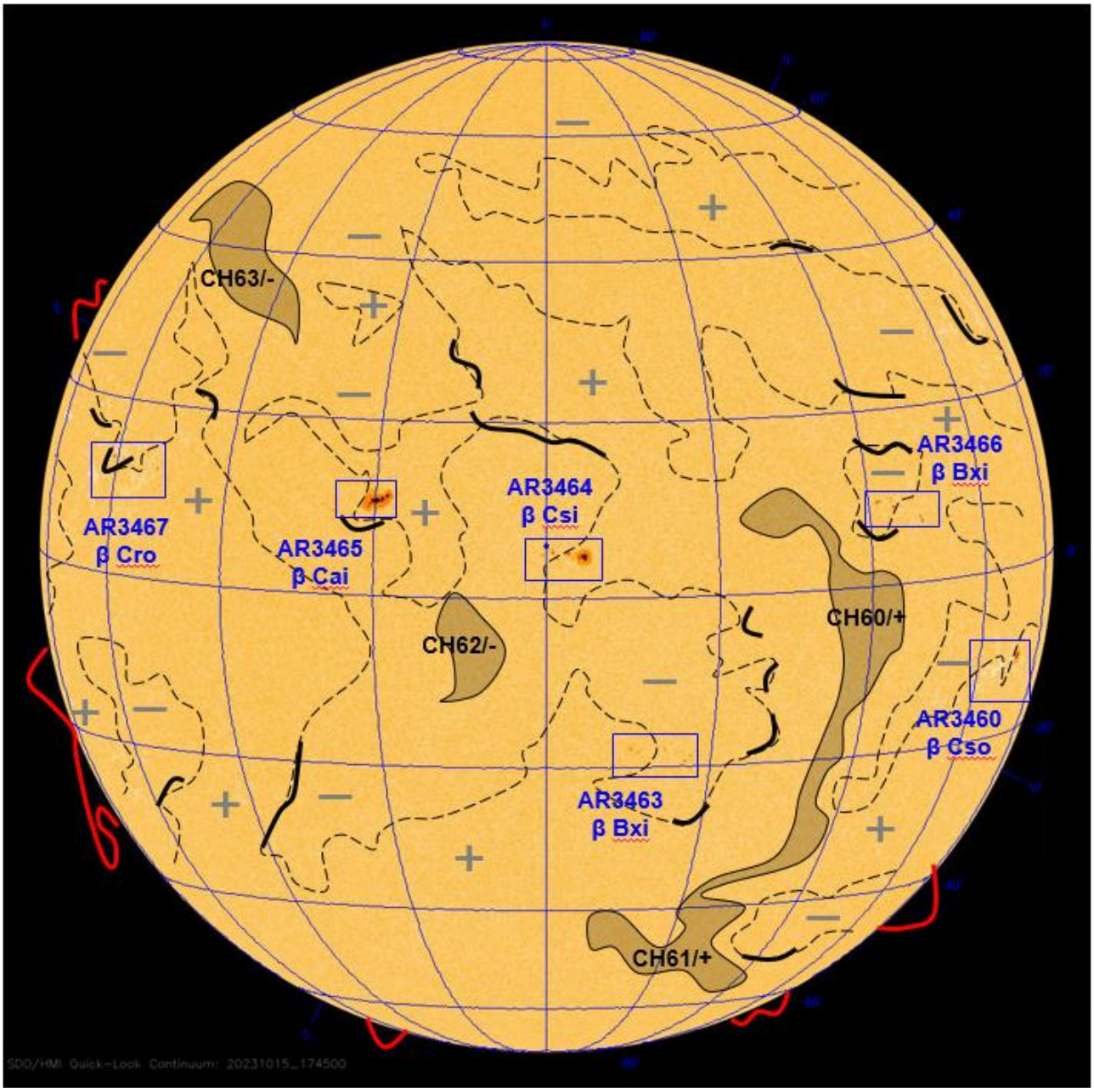
Figure 1. Solar Analysis Valid 15/1745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Earth is now considered to have departed the fast wind from CH58/-. The forecast therefore comprises the coronal hole fast wind from CH60/+, and up to two CMEs.

The coronal hole forecast is low confidence. CH60/+ is a narrow southern disc feature extending from mid-latitudes to the solar equator. Despite this geometry, MOSWOC Enlil appears to show any fast wind missing well to the south of Earth, which is considered improbable. Furthermore the persistence-based forecast is contaminated by CME effects on the last rotation, limiting its utility. Due to the positive polarity of CH60 and the time of year, there is considered a peak Chance for the period of G1, partitioned between the current UTC day (Monday 16 October) and Tuesday.

There are also up to two CMEs with potential Earth-directed components due midweek UTC. This first is from a corona-based dimming near N35W030 starting around 14/0340UTC. This has been modelled as delivering a possible glancing blow of Earth later in the UTC morning of Wednesday 18 October. Secondly, a CME was observed from a dimming and subsequent EUV filament channel north of AR3466 at 14/1240UTC, around N15W025. Given a similar inbound speed and emission longitude, this CME may add to or very closely follow the above CME glance, perhaps reaching 1AU concurrently or closely behind its stablemate.

Overall there is a bimodal risk of G1, probably highest late on Monday 16 October, but with a lower confidence secondary peak in risk on Wednesday 18 October. Conditions will perhaps be most reliably Quiet by Thursday 19 October in the absence of further drivers of activity.

Geo-Magnetic Storm	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Minor or Moderate	**G1 to G2**	No	30	20	30	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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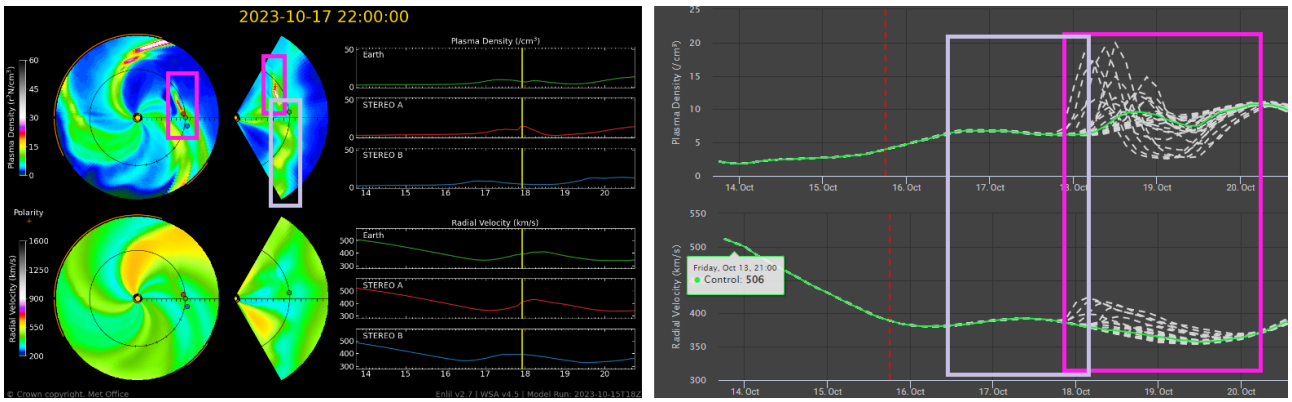
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1337	Partial	Filament	NW	448km/s	Late UTC morning Wed 18 Oct	Low confidence glance.
14/2152	Partial	Filament	NW	431km/s	Similar	Low confidence glance. Perhaps arriving with above.

Figure 2: 15/1800UTC MOSWOC Enlil run with ensemble, showing possible 14 October twin CME influence during the UTC morning of Wednesday 18 October (boxed magenta). Also shown in lilac is the possible influence of the CIR leading CH60/+. Enlil's thoughts as to the presence and strength of this feature have proven rather variable in the past 24 hours, however it appears unlikely that Earth will avoid CH60's fast wind, and arrival on the earlier side of the ensemble spread is preferred (i.e. the UTC morning of 18 October).



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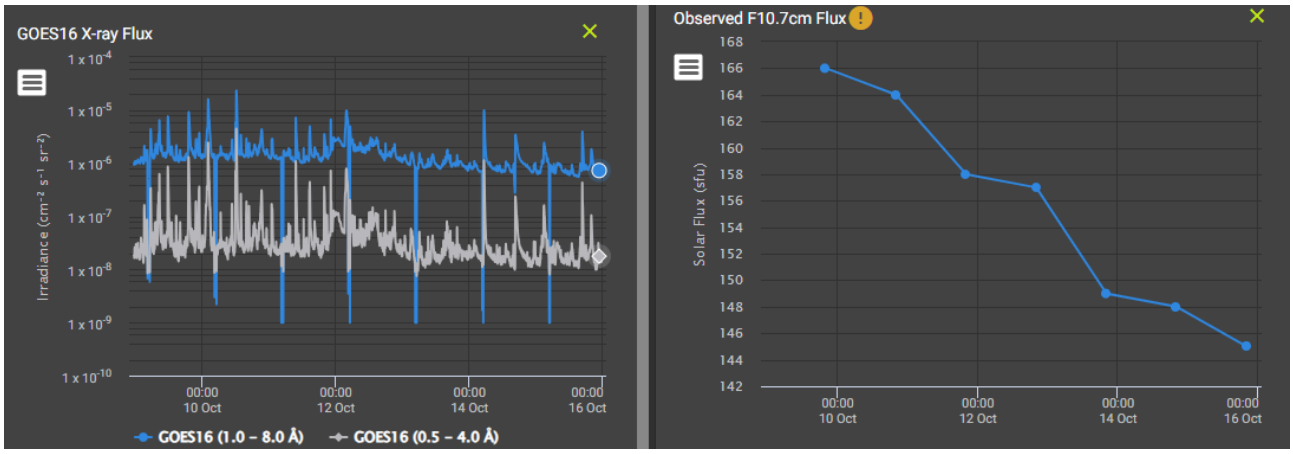
Radio Blackouts - X-Ray Flares:

Low activity is expected, with only six small and relatively simple sunspots currently on the visible disc. The main potential for increasing activity is from AR3464 in the central disc, which has shown some slow development in the last 24 hours due to the emergence of a small trailer spot with penumbra, although it retains a relatively simple magnetic classification of Csi/Beta for now.

EUV imagery suggests there remain a few sunspot regions yet to fully rotate onto the disc from stage left, with some recent CME activity perhaps related from the southeast, and with some minor northeast limb flares observed in recent hours. AR3460 is now a much-decayed remnant of its former self, and its departure from the front side around midweek is no longer likely to dent the daily M-class probabilities, which are instead bolstered earlier in the week by the likely new arrivals.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	30	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Past week in GOES16 and 18 X-ray flux and Penticton 10.7cm flux, showing an overall decline in activity. This trend is likely to reverse to a degree during the first half of the coming UTC working week as several returning regions arrive in the east.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels. Any increase to proton flux is unlikely, given the current visible disc sunspots.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The electron forecast is relatively low confidence for the period as a whole. This is in part due to the dissimilarity of coronal holes versus last pass, but also because of their close succession (especially recent delayed CH58/- and impending CH60/+) and the presence of possible CMEs. To this end, MOSWOC REFM is not felt to offer anything other than a general trend, which is currently hinting at levels approaching Active 24-hour fluence as a measure of potential.

The recent mainly Normal Background diurnal oscillation in flux at GEO should react upwards in the first 24 hours, but ought to be attenuated by geomagnetic activity arising from CH60/+ before the fluence troubles the Active threshold. The wake of CH60/+ ought to offer more favourable conditions for realising Active, however either of the pair of inbound CMEs will likely serve to interrupt and redistribute electrons before any lasting rise is seen.

Overall, a rising Chance of Active fluence is the preferred forecast for the four days as a whole, with flux levels more stable to end the week than starting it.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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